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LIFE CYCLE IMPACT ASSESSMENT (LCIA)

Review of criteria for evaluating LCA weighting methods

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Abstract
Purpose In the process of selecting where effective environmental measures should be directed, the weighting step of life cycle assessment (LCA) is an optional, controversial, but nevertheless important tool. A set of criteria for evaluating weighting methods has relevance in the process of acquiring meta-knowledge, and thus competence, in assigning relative weights to environmental impact categories. This competence is helpful when choosing between presently available weighting methods, and in creating new weighting methods.
Methods Criteria in LCA-related literature are reviewed. The authors have focused on identifying lists of criteria rather than extracting criteria from bulks of text. An important starting point has been the actual use of the term "criterion", while at the same time disqualifying certain definitions of the term which are too far removed from the two definitions provided in this article.
Results and discussion Criteria for evaluating weighting methods are shown to fall into two general categories. The first being general criteria for weighting methods, demanding that weighting methods have a broad scope, are practical for users and scientists, are scientific and have ethical goals. The second being criteria proposing characteristics of concrete environmental damage which should be taken into account by a weighting method. A noteworthy example is reversibility.
Conclusions While the comprehensive tables of criteria speak for themselves, it can be observed that the need for transparency is particularly highlighted in literature. Furthermore, ISO 14044's statement that the weighting step is "not scientifically based" would appear to defy a significant proportion of the other criteria reviewed; this, however, depends on its interpretation.

Keywords Criteria · ILCD · ISO 14044 · LCA · LCIA · Life cycle assessment · Valuation · Weighting

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1 Introduction

Life cycle assessment (LCA) is a standardised method for assessing environmental consequences in a life cycle perspective, and aims for a comprehensive approach to such consequences (Baumann and Tillman 2004). The assigning of relative weights to environmental impact or damage categories is an optional step in the life cycle impact assessment (LCIA) stage of LCA (ISO 2006). Such weighting can reveal which environmental impacts or damages are more significant for the process or product in question, and can be used for calculating a total environmental score. Weighting is controversial (Finnveden et al. 2006) as it is not an exact science, and some discourage its use completely (Schmidt and Sullivan 2002). However, without weighting, the most important impact categories for the system in question cannot properly be identified, and certain elements of decision-making thus risk being handled in an intuitive or arbitrary manner. This, in turn, could lead to the sub-optimal allocation of resources when there is honest societal effort in place to curb environmental damage. It is quite conceivable that, in cases where absolutely no reason is given to weighting, this sub-optimisation could become severe.

As shown by Ahlroth et al. (2011), weighting methods can be derived from various academic traditions such as economics, law or decision theory, and these traditions can lean towards different value bases (Berggren et al. 2007). Actually, choosing between weighting methods thus poses the challenge of determining which branches of science can be considered to be inferior and which superior for this kind of use. There are, unfortunately, insufficient structures in place for the resolution of such conflicts at an interdisciplinary level, and this could give the weighting step a problem with reproducibility. Unless criteria are established, a threat is that this confusion is resolved through arbitrary choices. As such, the need for criteria has recently been highlighted by the proposed meta-weighting method of Huppes et al. (2012), where default meta-weights, i.e. quantitative weights between weighting methods, according to the authors were set "quite arbitrarily."

Knowing which properties of weighting methods are desirable and which are not is of use for an LCA practitioner when deciding which methods or class of methods to use (Ahlroth et al. 2011; Huppes et al. 2012). An LCA theorist may also make use of criteria when deciding how to improve or create weighting methods, or when improving existing criteria or standards for weighting. Kruger and Dunning (1999) demonstrate that "the skills that engender competence in a particular domain are often the very same skills needed to evaluate competence in that domain". Consequently, the use of criteria for the weighting step or weighting methods can be seen to be a succinct approach to achieving competence within weighting. Criteria can thus be understood as reasons or arguments for choosing a particular starting point for weighting, and can provide an objective (or, intersubjective) basis for what otherwise may seem like subjective judgment, as explained by Hertwich et al. (2000).

This article primarily aims at finding criteria, and will also define more precisely what a criterion is. For brevity, it will only to a lesser extent be discussed whether particular criteria are desirable or not. As a starting point, it is assumed that every criterion found in scientific literature is relevant.

2 Methods

This article provides a review of lists of criteria for evaluating weighting methods recommended in literature. The literature has been found by searching for related keywords mainly using Google Scholar, by tracking relevant references in articles, and in physical libraries.

The focus has been on identifying lists of criteria rather than on extracting criteria from bulks of text. An important starting point has been the term "criterion"/ "criteria" and two particular definitions of this term were later found to be relevant to the weighting context—cf. section 4.1.

3 Results

The lists of criteria have been shown to fall into two general categories, distinguished by their level of abstraction. The general criteria reviewed are mainly abstract and decontextualised in relation to the environment, while the concrete criteria reviewed have a stronger link to concrete and, in theory, empirically available information regarding the environment.

Lists of general criteria found are presented first, followed by lists of criteria related to concrete impacts and damages.

3.1 General criteria

Several of the lists of general criteria are linked to a comprehensive SETAC process which aimed to recommend a scientific basis for LCIA (Udo de Haes et al. 2002).

3.1.1 Powell et al. (1995)

Powell et al. (1995) give four lists or sets of criteria for weighting methods. All are listed in Table 1. The first is found in Braunschweig et al. (1994), a list of criteria assembled by The Swiss Federal Laboratories for Materials Testing and Research. Magnussen et al. (1998) adopted the criteria proposed by Braunschweig et al. (1994) when evaluating individual weighting methods, and added two more, as listed in Table 1. According to Magnussen et al. (1998), Braunschweig et al. (1994) compiled their list of criteria after starting from a longer list of ideal, but partly contradictory, criteria. Hofstetter (1996, p. 134f) in Braunschweig et al. (1996) sets out comprehensive lists of criteria subordinate to each of the four criteria of Braunschweig et al. (1994), extracted from a draft paper by Lindeijer (1995). For brevity, they are not included in this article.

The second list, connected to SPOLD, was presented by Grisel et al. (1994), and the third was given by Baumgartner and Rubik (1993). This latter includes criteria for the whole of LCA and not only the weighting step, but is, however, included as the two can be seen to have overlapping, or consistent, goals.

In addition, Powell et al. (1995) themselves pick five criteria. These criteria are applied in an article connected

Table 1 A comparison of lists of general criteria in literature

		Braunschweig et al., 1994	Grisel et al. (1994)	Baumgartner & Rubik (1993)	Powell et al. (1995)	Magnussen et al. (1998)	Finnveden (1999)	Finnveden et al. (2002)	Huppes and van Oers (2011)
Broad scope	Completeness/Comprehensiveness	X			X	X	5, 11, 12	N	II, III, IV
	Include inter-effect weighting						3	*J*	
	Flexibility to include new problems						6		
	New value choices and characterisation methods can be included						6	*M*	
	Possibilities for further development						6	P	
Practical for users	Practicality	X			X	X	2		VIII, XI
	Presentation			X			5, 13, 14, 15		
	Reflecting the subjectivity of weighting						1, 12, 17	*I*	
	Geographic and temporal representativeness								X
Practical for scientists	Feasibility		X				2		XI
	Low requirements on amount of data						2	A	
	Good availability of data						2	B	
	Low requirements on technical skills						2	C	
	Low efforts needed for the execution						2	K	XI
Ethical	Content	X				X	5		III, IV
	Fairness			X			12, 17		
	Goal acceptability				X		12, 15		VI
	Acceptability of category of weighting method					X	1, 17		I
	Follows established standards for LCIA					X	2		IV
	Adequate representation of values						12, 17	*H*	VI
Scientific	Transparency	X	X	X	X	X	7, 10	*D*	
	Objectivity		X				19		
	Reproducibility (or Repeatability)		X	X			7, 8, 16	*R*	VII
	Relation to available and "best available" characterisation methods						9, 19	O	II, III, IV, XI
	Goal consistency				X		9, 18		
	Acceptable scientific practice in the sciences used						19	*G*	V
	Clear discernment of objective and subjective elements						4	*E*	
	Systematic approach						18	*F*	
	Robustness or sensitivity						4	S	
	Consistent results and transitivity						7, 8, 16	*Q*	
	Treatment of uncertainty								IX

The authors of this article have sorted individual criteria into five categories, and labelled them as follows, from brighter to darker: "Broad scope", "Practical for users", "Practical for scientists", "Ethical", and "Scientific". The criteria of Finnveden (1999) and Huppes and van Oers (2011) have been incorporated into the table through our judgment

to the 6th SETAC-Europe meeting which compares individual weighting methods (Powell et al. 1997).

3.1.2 Finnveden (1999)

The sets of criteria listed by Finnveden (1999) are based on aspects "largely determined by the author's ability to say something about the method which may be of interest for a wider audience". It quotes a comprehensive list of criteria from a SETAC-Europe subgroup on normalisation and valuation, which is divided into two parts. These criteria are as follows, quoted directly from Finnveden's paper:

"General requirements":

1. Reflect the subjective characteristic of weighting in general
2. Fit the purpose of the LCA, including time/money constraints, communication requirements and effectivity for control action
3. An inter-effect weighting should be included somehow
4. Deal with uncertainty
5. Applicable to all present environmental problems
6. Flexibility to include new problems
7. Be explicit/transparent; e.g. be explicit on the weighting criteria used, perform all weighting substeps explicitly and ensure verifiability
8. The units for expressing the impacts should make no difference for weighting
9. Use exactly the same formulation of problem types as in classification and characterisation

"Possibly contradictory requirements":

10. Keep the weighting principles simple and understandable
11. Include all available natural science information
12. Incorporate general interests of all involved agents
13. Differentiate for regions and time discounting
14. Use single scores or indices for optimal communication

15. Use weights only for ranking and include qualitative information when this is necessary
16. Reproducibility
17. Allow for societal discourse on weights

Two requirements are added by Finnveden:

18. The weighting method should not contain any logical errors or contradictions
19. The science used (including all types of science) should be the best available in the respective area.

Each criterion has tentatively been incorporated where it best fits in Table 1.

3.1.3 Finnveden et al. (2002)

The conclusions of SETAC-Europe's Second Working Group on LCIA define a number of criteria for weighting factors (Finnveden et al. 2002). Criteria are divided into three categories with in total 14 main criteria, some of which are divided into sub-criteria.

In the same work, a tentative evaluation of weighting methodologies using said criteria is performed. For the sake of brevity only criteria from this evaluation will be included in Table 1. The criteria shown in *italics* in the table are suggested by Finnveden et al. as "must candidates". The rest are labelled "nice-to-have criteria". They are incorporated in Table 1 as elements A–S, and are essentially quoted directly from the original as shown in the left column of the table. A–C are classified as "input-related criteria", D–P as "procedure-related criteria", and Q–S as "output-related criteria".

3.1.4 Huppes and van Oers (2011)

In a background review for the European Commission on existing weighting approaches, as part of supporting the construction of an overall EU eco-efficiency indicator, Huppes and van Oers (2011) give a set of criteria. They "form a basis for reasoned choice, but mostly they are not direct evaluation criteria." An exact reproduction of their criteria is as follows (numerals added):

I. Weighting procedure: distance-to-target, panel;
II. Modelling of cause–effect chain;
III. Environmental interventions covered;
IV. Impacts covered, connection to generally accepted impact indicators and in particular to those of the ILCD;
V. Scientific quality and acceptance of the method;
VI. Societal acceptance of the content;
VII. Reproducibility;
VIII. Range of applicability;
IX. Treatment of uncertainty;
X. Geographic and temporal representativeness;
XI. Degree of being operational.

They state that "in making choices, the operationality requirement is the most important in this project." The criteria have tentatively been fitted into appropriate rows in Table 1 for comparison with other lists of criteria.

3.1.5 Other general criteria

This sub-chapter gives lists of criteria which are not easy to compare with the above lists, and which therefore are not included in Table 1. Some of the lists have a more general character; it is not clear how complete some of the lists are intended to be; and some are presented divergently. It should be noted that their exclusion from the table does not imply that they are judged to be of inferior quality.

Hofstetter (1998) refers to the criteria of Hofstetter (1996, p. 134f) which are presented in the next paragraph, but chooses to use another set of criteria because "it is dangerous to evaluate one's own framework with one's own list of criteria". He refers to seven criteria by Hyman et al. (1988), which are not directly linked to weighting in LCA, but to the applicability of environmental impact assessment tools as decision support. The list is given in Table 2 as presented by Hofstetter (1998).

In 2006, the ISO 14044 standard (ISO 2006, p. 22) narrowed down possible perspectives towards weighting into what are essentially two very general criteria:

- Weighting steps are based on value choices
- Weighting steps are not scientifically based

A site-dependent weighting method for Canada has been developed (Soares et al. 2006). It endorses the criteria of Finnveden et al. (2002), and also gives an additional number of general criteria. These criteria are not listed, for the sake of brevity and because they do not differ significantly from those found in Table 1. Two of the criteria, however, stand out in relation to what has been presented above:

- Must take into account country specificities and policies
- Must be simple to re-calculate depending on the goal and scope of the LCA study

In addition, Soares et al. use a multi-criterion decision analysis (MCDA) approach, in which the term "criterion" is used, but with a definition which differs from that of the above general criteria. They are better included under the next paragraph, which reviews lists of more concrete criteria.

Huppes et al. (2012) state that the "default" set of relative weights that they give to different weighting methods—as a

Table 2 Criteria of Hyman et al. (1988) according to Hofstetter (1998)

Less preferable	More preferable
Attributes of natural systems:	
Treats impacts as deterministic	Explicitly recognises risk probabilities
Examines direct effects only	Examines indirect and feedback effects in addition to direct effects
Assumes relationships are static	Considers dynamic aspects or changes in relationships over time
Characteristics of planning and of decision-making attributes	
Emphasises a single objective	Adopts a multiple-objective approach
Blurs facts and values	Clearly separates facts from values
Relies on expert judgements only	Encourages public participation
Uses money, time and resources inefficiently	Uses money, time, and resources efficiently

starting point—is "quite arbitrary", but nevertheless based on three criteria:

- Transparency
- Well-developed underlying models
- Correspondence to ILCD

ILCD, in turn, is the European Commission's handbook on best practice in LCA. It was developed "for greater consistency and quality assurance" in LCA, in order to address threats to "the reliability and comparability" of LCA results (Wolf et al. 2012). It recommends the following "considerations" to guide the selection or identification of weighting factors (European Commission 2010, p. 114):

- Relate to the normative/cultural/religious or other societal setting globally or of the country or region where the supported decisions are made (Situations A, B), or the reference of the accounting (Situation C).
- Relevance for the intended application(s) and target audience of the LCI/LCA study
- Refer correctly to the specific set of midpoint level impact categories or endpoint level Areas of protection provided by the LCIA method used for the study
- Be regarding chosen country, region or global scope compatible with the set of normalisation factors that were applied, if any

As weighting methods are linked to a set of practices for the rest of LCIA, Huppes et al. (2012) could also be interpreted to explicitly demand correspondence to ILCD's recommendations for LCIA in general, in line with Huppes and van Oers (2011). The four points above also indicate this interdependence. Hence, it is not obvious that it is appropriate to disconnect them from their proper context.

It should be noted that at the time this review was written, the entire ILCD handbook was not yet finished.

3.2 Criteria related to concrete impacts and damages

Hofstetter (1996, p. 174f) in Braunschweig et al. (1996) gives lists of criteria from five other sources, where the starting points are features of environmental impacts and damages rather than considerations at a level of abstraction above this. These five lists are shown in Table 3.

The first of these is from a paper which appears to be an early version of Schmitz et al. (1995). In the second, four criteria are mentioned in three different contexts in Braunschweig et al. (1996). Müller-Wenk and Braunschweig (1996, p. 232) label them as "essential for the determination of valuation weights". This list of four criteria is twice appended by one more criterion by Hofstetter (1996, p. 174) and Müller-Wenk (1996, p. 95), respectively. The third list of criteria referred to by Hofstetter (1996, p. 174f) is attributed to Volkwein et al. (1996). The fourth list covers criteria *implicitly* used by experts for weighting according to Kortman et al. (1994). Lastly, still according to Hofstetter, Lindeijer in an early version of Udo de Haes (1994) proposed the following weighting criteria:

- Seriousness of the harm
  - Extent of exceeding reference level
  - Reversibility

    For irreversible harms: risk of extinction, extent of damage, importance to life on Earth
    For reversible harms: extent of stress, time-extent of stress, geographical scale of stress, importance of system
- Dynamics of the harm
  - Trend in future seriousness of harm
  - Complexity of the causal chain
  - Administrative, technical, economic effort to reduce harm
  - Timespan required to reduce harm

Table 3 Criteria related to concrete impacts and damages

	Hofstetter in Braunschweig et al. (1996)	Müller-Wenk & Braunschweig in Braunschweig et al. (1996)	Volkwein et al. (1996)	Kortman et al. (1994)	Lindeijer in Udo de Haes et al. (1994)	Soares et al. (2006)
Ecological / ecosystem threat potential	X		X	X	(X)	X: Ecosystem health
Irreversibility	X	X: Reversibility	X	X: Expected effort to return to an acceptable level	X: Trend in future seriousness of harm	X: Reversibility
Scale of effect (global-local)	X	X: Geographical extension of damage	X: Extension	X: Contribution by/threat to the Netherlands	(X)	X: Scale (significance of region)
Substitutability of damaged item		X				
Uncertainty of damage		X	X	X	X: Complexity of the causal chain	X: Uncertain-ty of all criteria
Probability of occurrence				X		
Endangering human health				X		X
Nature of the effects				X	(X)	
Natural resource use						X
Distance to target	X	X: Ecological scarcity/distance to target	X	X: Relative harmfulness of expected effects	X: Extent of exceeding reference level	X
Time lag in impact chain		X	X: Time lag between emission and impact		X: Timespan required to reduce harm	X: Duration (time)
Possibility for administrative solutions				X	X: Effort to reduce harm	
Preferences of population	X		X			
Willingness to pay			X			
“Others”			X	X		

We interpret the brighter-toned criteria to be threats to the environment from natural processes, and the darker-toned criteria to be threats in relation to human indecisiveness. We do not know whether the darkest criteria are intended as encouragements to incorporate public participation, or as warnings that public preferences are threats to decisiveness and thus belong in the middle category

As Lindeijer’s list has contingencies and several levels, it does not fit the table format perfectly, and thus some information is lost when transposing it to Table 3.

The same applies for the hierarchically structured criteria of Soares et al. (2006), which are also tentatively incorporated into Table 3. The following criteria, as defined in MCDA, are used by Soares et al. for evaluating (or, weighting) each respective impact category, by a panel assigning a value to each criterion.

- Criteria for environmental consequence
  - Human health
  - Ecosystem health
  - Natural resources
- Criteria for the level of environmental consequence:
  - Scale (significance of region)
  - Duration (time)

  - Reversibility
  - Distance-to-target
- Uncertainty

4 Discussion

Using the list format is not the only way of documenting criteria. For instance, Braunschweig et al. (1996) and Huppes and van Oers (2011) cover a broad range of arguments and discussions surrounding weighting which cannot easily be summarised in such lists. Moreover, an adherence to the list format has the weakness that an in-depth definition cannot be provided for each criterion, in part for the sake of brevity, but in part also because the literature reviewed does not always provide definitions. Furthermore, when applying such criteria, one meets a challenge well known from the subject-matter in question: that of balancing the relative importance of each individual criterion. However, as is also the case with impact and damage categories, they are not necessarily independent. There may be hierarchical or lexicographic ordering, or other forms of cohesion, between criteria. The result is a certain degree of illusory simplicity within simple lists of criteria. Together with the fact that there are a large number of criteria, particularly amongst those classed as abstract, this poses a risk. Criteria may be hand-picked for ad hoc argumentation in favour of a pre-defined conclusion, rather than for use in an open-ended inquiry. Hence, it is obvious that lists of criteria cannot and should not replace analytical insight and reflection.

Notwithstanding, this review of lists of criteria provides a concise overview of the analysis of weighting methods, as well as possible starting points for the creation of new methods.

4.1 The two definitions of "criterion"

The criteria presented have been grouped into abstract (general) criteria and concrete (specific) criteria. They represent two different approaches to weighting methods, which can be seen as complementary. If a weighting method is judged to *fulfil* a general criterion, or if it is judged to appropriately *address* a concrete criterion, this can be claimed as an *argument* for a conclusion that the weighting method is "good" or "preferable". It could be of note that, as they are more directly prescriptive and provide scarce procedural requirements, a choice to rely on concrete rather than general criteria may lead to a stronger dependence on the "scientific" process through which they were crafted. This may or may not be at odds with a "democratic" process or with processes otherwise anchored explicitly in categories of ethics.

4.2 Cohesion between general criteria

Some of the literature found is more than 10 years old, but still appears to form a significant part of the current overarching understanding of the weighting step. It is noteworthy that the criteria of ISO 14044 and the ILCD Handbook seem unrelated to or only loosely based on earlier, similar undertakings.

The criteria of ILCD, or at least the ones reviewed, focus primarily on the proper coupling of weighting to the context of each LCA study and to the other modules of LCIA. This provides a strong emphasis on, and a more specific definition of, the goal consistency criterion of Powell et al. (1995). ILCD's demand for an appropriate link to the normalisation step can be seen as covered by the independence of unit criterion (number 8) of Finnveden (1999), which is included under "Consistent results and transitivity" in Table 1. ILCD is also in line with Soares et al. (2006) in demanding site-dependent weighting. The two extra criteria provided by Huppes et al. (2012), "transparency" and "well-developed underlying scientific models" provide a link between ILCD's relatively narrow focus on consistency and criteria in other literature.

As there are numerous general criteria, we have divided them into five main categories, as shown in Table 1. Such division can be carried out in a number of ways; in fact our subdivision can be said to simply complement those of Braunschweig et al. (1994), Grisel et al. (1994), Baumgartner and Rubik (1993), Powell et al. (1995), Finnveden (1999) and Finnveden et al. (2002). A noteworthy relationship is that between expansive (broad scope) and restrictive (practical, ethical and scientific) criteria. Perhaps the most glaring inconsistency was found to be that between ISO 14044's criterion that weighting methods are "not scientifically based", and the many criteria in Tables 1 and 3 demanding that weighting is anchored in scientific method and science, respectively. This issue was addressed by Hertwich et al. (2000). Notwithstanding, it does not seem to be fully resolved.

It is also noteworthy that most of the lists leave it up to the context to decide moral input; only a couple of the lists include fairness as a criterion; none of them mention sustainable development. The moral input in weighting, in turn, is related to power. It seems inescapable that a central coordination or leadership of weighting factor "creation" at the end of the line is performed by, typically, scientists; accordingly, as a starting point, these scientists have total power. Some criteria, such as "fairness" and "encourages public participation", can thus be understood to concern norms pertaining to acts of leadership. However, precisely how, why, and exactly to whom or what, the power inherent to this leadership can be delegated or allocated in the effort to avoid a mere dictate by, hypothetically, an individual scientist's accidental opinion, is perhaps not univocally

and explicitly explained by the general criteria reviewed. How does a weighting method's relevance arise, and where does its moral authority reside?

4.3 Concrete criteria: starting points for activity?

Anything concrete is, generally speaking, more closely linked to "how" questions than to "why" questions. The concrete criteria are thus by definition more down-to-earth. As weighting is difficult to comprehend, this practical dimension can make these criteria particularly useful. When it comes to the creation of weighting methods on the basis of criteria, Soares et al. (2006) calculate weighting factors more or less directly from a panel evaluation of their concrete criteria, using MCDA methodology. MCDA provides an opportunity for directly applying concrete criteria such as those in Table 3 in a weighting methodology.

The concrete criteria ought to somehow be compatible with the general criteria. Table 4 shows a suggested comparison between the two as presented in Tables 1 and 3. The comparison is, of necessity, influenced by the authors' point of view. The content of the table is likely to vary for different impact categories. The table could give an indication of the areas of inquiry which need be included in a weighting method. It can, perhaps, also reveal certain topics that risk underestimation because of the scientific difficulty in including them. We recommend that criteria which can be described as "practical for scientists" (cf. Table 1) be regarded with a degree of scepticism. It can sometimes be preferable to direct more rather than less effort and attention towards relevant, but scientifically less convenient areas. It is also noteworthy that several of the studies do not seem to include criteria for this category.

5 Conclusions

As this is primarily intended as a review of criteria, the main finding of the article is simply the information provided in Tables 1, 2 and 3. Transparency is the most recurrent of the single, general criteria. The general criteria fall into five categories, although, as discussed, a number of partitions are realizable.

Table 4 Suggested compatibility between criteria in Table 3 and the five categories of criteria as identified in Table 1

	Broad scope	Practical for users	Practical for scientists	Ethical (suggestions)	Scientific
Ecological / ecosystem threat potential	X	(X)	(X)	X	(X)
Irreversibility	X	(X)	*No?*	X	(X)
Scale of effect (global-local)	X	X	(X)	*Dilemmas arise*	X
Substitutability of damaged item	X	(X)	*No?*	X	(X)
Uncertainty of damage	X	(X)	(X)	X	(X)
Probability of occurrence	X	(X)	(X)	X	(X)
Endangering human health	X	X	X	*Removes focus from ecosystems?*	X
Nature of the effects	X	(X)	?	?	?
Depletion of resources	X	X	X	*Not intrinsic values*	(X)
Time lag in impact chain	X	(X)	?	X	(X)
Distance to target	X	X	X	*Depends*	?
Possibility for administrative solutions	X	X	*No*	X	?
Preferences of population	X	X	X	?	?
Willingness to pay	X	X	X	?	?

X denotes compatibility, (X) partial compatibility

The reviewed literature's persistence in recommending scientific principles as a basis for weighting is potentially challenged by the ISO 14044's recommendation to approach weighting on the basis of value choices rather than science (ISO 2006, p. 22). It is somewhat confounding that the criteria of influential documents like ISO 14044 and the ILCD Handbook do not seem to be specifically founded on the reviewed criteria. However, the reviewed recommendations of ISO 14044 do not necessarily oppose a division of the weighting step as a whole into scientific modules and value-choice based modules as long as the former somehow is anchored in the latter; hence, the conflict could be illusory. Moreover, academia does not only comprise science; both science and values are objects of academic inquiry. If the burden of starting and coordinating weighting inquiry remains with scientists, it would seem to be an obvious choice to consult academic disciplines which relate to value choices for advice on how to ease this burden in an optimally charitable manner.

Thus summarising, the weighting step seems to be inadequately understood in the LCA community, and its workings appear to be regarded as somewhat mystical. It is to be hoped that this article contributes towards an improved confidence in relation to weighting, and that it may be a cause of progress concerning the important link between LCA and well informed decisions. The criteria reviewed could also be applicable in other fields where discussions surrounding the question of which environmental impacts are important or unimportant lack the basic arguments required for resolution.

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